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Observation of Multiple Mechanisms For Stimulating Ion Waves in Ignition Scale Plasmas

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The scattering of intense laser beams by stimulated ion acoustic waves has long been recognized as an important loss mechanism for inertial confinement fusion experiments. The planned National Ignition Facility (NIF) will use multiple laser beams to illuminate targets containing large scale plasmas. These conditions have been simulated in a series of experiments on the Nova laser facility where it has been found that there are at least three important ways in which ion waves can be stimulated. First ion waves can be stimulated by a single laser beam by the process of Stimulated Brillouin Scattering (SBS) in which an ion acoustic and a scattered electromagnetic wave grow from noise. Second, in a plasma where more than one beam intersect, ion waves can be excited at the 'beat' frequency and wave number of the intersecting beams, causing the side scatter instability to be seeded, and substantial energy to be transfered between the beams. And third, ion waves may be stimulated by the electron plasma waves produced by Stimulated Raman Scattering (SRS), and thereby inhibit the SRS process. Experiments have demonstrated each of these effects in a large, hot plasma that is comparable to plasmas expected in NIF. Results indicate that 1) the SBS reflectivity from low density plasmas is lower than predicted by homogeneous plasma theory, 2) the SBS gain measured in the two beam seeding experiments is also low, although the gain is unsaturated at high seed amplitude so that as much as 50% of the energy is transferred between the beams, and 3) the SRS reflectivity in high Z plasmas is proportional to the ion wave damping, and has a magnitude that is consistent with the electron wave amplitude necessary for the secondary decay instability. The first two results can be reconciled with models including large amplitude ion wave turbulence while the third indicates a possible source of turbulence. Work performed for US DoE under contract# W-7405-Eng-48 by LLNL.